Species Composition, Abundance and Distribution of Cephalopod Paralarvae in the South China Sea: Sabah, Sarawak (Malaysia) and Brunei Darussalam Waters

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Abstract

Samples from 20 stations in Sabah, Sarawak (Malaysia) and Brunei Darussalam Waters were collected between 20th March – 1st April 2000. At each station one oblique haul of the bongo net was made from 100 meters deep to the surface. The ship's speed was about two knots. There were one hundred and fifty two specimens of cephalopod paralarvae and these were identified into twenty species of nine families. The most abundant was the family Enoploteuthidae (41.59%) followed by Ommastrephidae (25.64%), Octopodidae (16.74%), Loliginidae (6.99%), Cranchiidae (5.73%), Sepiolidae (1.38%), Octopodoteuthidae (1.12%), Onychoteuthidae (0.46%) and Gonatidae (0.33%). The distribution pattern of the cephalopod paralarvae in this study area was scattered both inshore and offshore, especially in the northern part of the survey area.

Key words: Cephalopod, Paralarvae, Species Composition, Abundance, Distribution and South China Sea

Introduction

Information on cephalopod paralarvae in terms of taxonomy, biology, spawning ground, spawning period and rearing ground in the Southeast Asian countries is needed to support fisheries management. Especially as at present the catches of cephalopod in the Southeast Asian countries have been increased and are also close to the level of effort yielding the maximum sustainable yield (Siriraksophon, 1999) so this information are very high value data for planning sustainable squid fisheries management in the region. The author hopes that this paper (Species Composition, Abundance and Distribution of Cephalopod Paralarvae in the South China Sea: Sabah, Sarawak (Malaysia) and Brunei Darussalam Waters) will be valuable for formulating a sustainable squid fisheries management program in the region.

Review of Biology of the Cephalopod

Cephalopod (class cephalopoda) consists of four groups: the chambered nautilus; squid; cuttlefish; and octopus. The total number of existing species of cephalopods is more than 1000, distributed in 43 families (Ruper *et. al.*,1984). Cephalopods occur in all marine habitats of the world: benthic; cryptic; burrowing on coral reefs; grass flats; sand; mud and rock; epibenthic; pelagic and epipelagic in bays; seas and in the open ocean. The range of depths extend from the surface to below 5000 m. The abundance of cephalopods varies (depending on the group, habitat, and season) from isolated territorial individuals (primarily benthic octopods) through small schools with a few dozen individuals, to huge schools of neritic and oceanic species with millions of specimens.

The four groups of cephalopods are easily distinguished by their external characteristics. The chambered nautiluses are characterized by an external, smooth, coiled, chambered shell, circumoral appendages without suckers, a "funnel" consisting of two flaps or lobes, simple eyes without lenses and the absence of an ink sac. Squids have an elongate, torpedo-like body with posterolateral fins, and eight circumoral arms, not connected at the base with a web, with two (occasionally more) rows of stalked suckers bearing chitinous rings (and/or hooks) running over the entire length. They also have two long tentacles with an organized cluster (tentacular club) of two or more rows of suckers (and or hooks) at the distal end. The cuttlefish have a broad sac-like body with lateral fins that are either narrow and extend the length of the mantle (Sepiidae) or are short, round and flap-like (Sepiolidae). In both cases the posterior lobes of the fins are free (subterminal) and separated by the posterior end of the mantle; ten circumoral appendages, the longest (4^{th}) pair (tentacles) are retractile into pockets at the ventrolateral sides of head. The eight arms frequently have 4 rows of stalked suckers with chitinous rings. The eyes are covered with a transparent membrane with eyelids; the shell is thick, chalky, calcareous (cuttlebone of sepia) or thin, chitinous (sepiolidae). Octopus have a short, sac-like body with either no lateral fins or with separate paddle-like fins in some deep-sea forms, and eight circumoral arms only (no tentacles) with the bases connected by a membranous web and un-stalked suckers, without chitinous rings, along the length of the arms.

All cephalopods are dioecious (separate sexes) and many, though not all, exhibit sexual dimorphism, either in structure or size differences. Females are generally bigger than the males. Males of many forms possess 1 or 2 modified arms (hectocotylus) that are used for mating. The hectodotylus may consist of modified suckers, papillae, membranes, ridges and grooves, etc. In any case these function to transfer the spermatophores from the male's mantle cavity to a locus of implantation on the female, which may occur inside the mantle cavity, around the mantle opening on the neck, in a pocket under the eye and around the mouth. Fertilization takes place in the female as the eggs are laid. The eggs of squid are generally encased in a gelatinous matrix secreted by the nidamental glands. They are laid as multi-finger-like masses attached to rocks, shells or some other hard substrate on the bottom in shallow water (inshore squid), or they are extruded as large, singular, sausage-shaped masses that drift in the open sea (oceanic squid). The mode of reproduction and egg laying is unknown for many forms, especially oceanic and deep-sea species. Cuttlefish lay relatively few, large grape-like eggs that are attached to hard substrates and are usually colored black with a covering of ink deposited by the female at the time of egg-laying. Benthic octopus lay their eggs in great, grape-like clusters and strands in lairs, under rocks and in abandoned mollusc shells, where they nurture them until they hatch. The eggs are attached to each other, but they are not encased in a gelatinous matrix. The female of the pelagic octopus constructs a thin, shell-like egg case in which she resides and lays festoons of eggs, fertilization having taken place from sperm contained in the highly modified hectocotylus that was autotomized (detached) from the male and deposited in the egg case. The life expectancy of a cephalopod is about one or two years in most forms, but the larger species of squid or octopus, for example, the giant squid and the giant octopus live for several years. Many species die after spawning, but this phenomenon is not universal apparently.

Cephalopod eggs have very large yolks, hence cleavage is incomplete, so that the typical mollusc spiral cleavage is absent. Development is direct to the young hatch as miniatures of the adult. Thus, no discrete larval stages or metamorphosis occur. Cephalopod eggs may vary in size from about 1.7 cm. long in some demersal and pelagic species to 0.8 mm. The eggs of the *Sepia* can attain 9 or 10 mm in diameter. The time of embryonic development also varies widely, from a few weeks to several months, depending on the species and the temperature conditions. Hatching may occur rapidly from a single clutch or be extended over a period of 2 or 3 weeks. At hatching, young animals often are to be found in different habitats to the adults.

Many species of oceanic cephalopods undergo vertical migrations, wherein they occur at depths of about 400 to 800 m. during the day, then ascend into the uppermost 200 m. or so during the night. While shallow-living cephalopods are able to disguise themselves by chromatophore-produced color patterns and chameleon-like color changes, many deep-sea forms camouflage themselves by producing bioluminescent light from photophores (light-producing organ) which eliminates their silhouette against the down welling light in the dimly-lit mid-depths.

Cephalopods are carnivores. They eat fish, crustaceans, shellfish, etc. In turn, cephalopods are a major food item in the diet of toothed whales, seals, pelagic birds and both benthic and pelagic fishes (e.g., sea bass, lancetfish, tuna, billfish, sharks and rays).

The role of the cephalopod in the ecosystem seems to be that of subdominant predators which tend to increase in biomass when other species (particularly their predators and competitors for food) become depleted as a result of heavy fishing. This has been observed, for example, the trawl fisheries in the Gulf of Thailand.

Materials and Methods

The specimens in this report were sorted out from 20 stations of 21 oceanographic stations in the South China Sea, Sabah, Sarawak (Malaysia) and Brunei Darussalam waters (see Figure 1 and Appendix I) by researchers on M.V.SEAFDEC (Cr.61-1/2000) between 20th March – 1st April 2000.

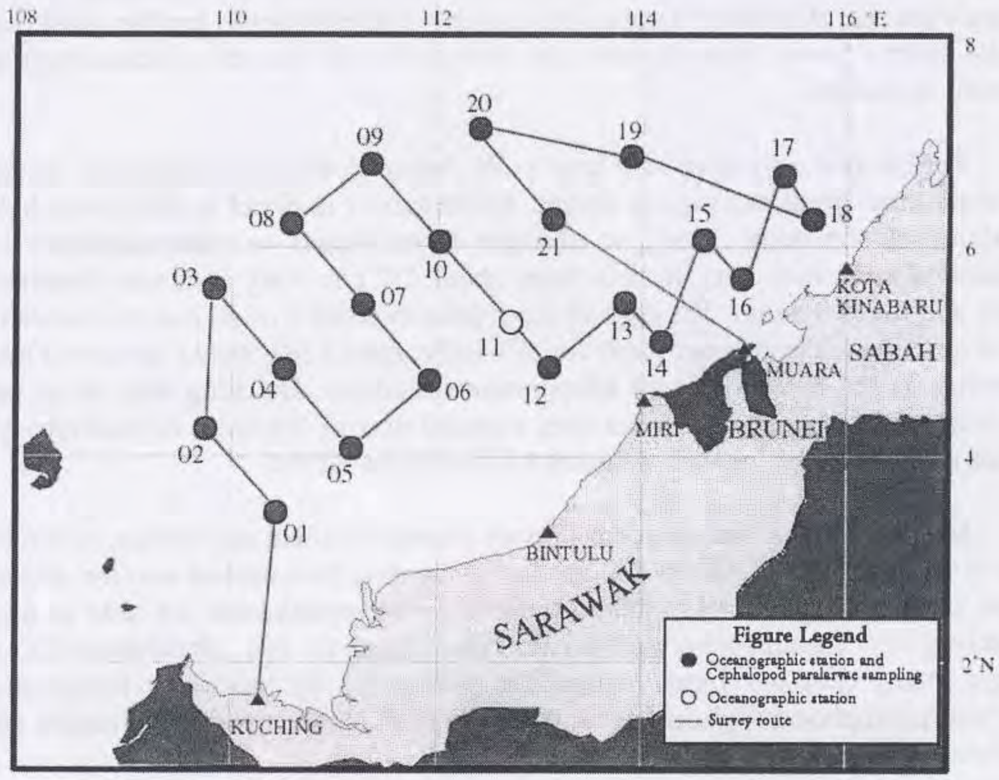

Figure 1. *Station positions for the survey*

The samples were collected using a bongo net, 60 cm. in diameter with a mesh size of 500 micron at the mouth part and 330 micron at the cod end. A flow meter was attached to the mouth part for measuring the volume of water filtered. The sampling period was about 30 minutes at a ship speed of about 2 knots. The net was obliquely hauled from a depth of 100 m. to the surface. The specimens were preserved in 10% formalin and seawater immediately after each haul. Sorting and identification was carried out in the laboratory. After sorting, the cephalopod paralarvae were preserved in 4-5% formalin/seawater mix. Identification and illustration was performed using a stereomicroscope. Specimens were identified to the genera or species level. Their abundance and distribution were estimated in terms of number of individuals per 1000 cubic meters (No./1000 m^3) of seawater using the following formula (Jivaluk, 2001):

$$T = \frac{1000 \times t}{\pi r^2 d}$$

when T = number of cephalopod paralarvae in 1000 m^3
t = number of cephalopod paralarvae each station
r = radius of bongo net (m)
d = calibrated value x revolution number of flow meter

Calibrated value is the average value of flow meter drop to 30 meters depth from the sea surface.

The keys used in this identification by morphology were based on Allan (1945), Kubodera and Okutani (1981), Okutani (1966), Okutani (1968), Okutani and McGowan (1969), Tsuchiya *et.al.* (1991), Yamamoto and Okutani (1975), Young and Harman (1985), Young *et.al.* (1989), Michael *et.al.* (1992) and Jivaluk (2001).

Results and Discussion

The cephalopod paralarvae were identified as being twenty species of nine families, except for those unclassified (Table 1).

Table 1. The cephalopod paralarvae identified to the generic or species level.

Family Cranchiidae	*Liocranchia* sp. *Liguriella* sp.
Family Enoploteuthidae	*Enoploteuthis* sp. *Abralia* sp. *Abraliopsis* sp.
Family Gonatidae	*Gonatus* sp.
Family Loliginidae	*Loligo* sp.
Family Octopodoteuthidae	*Octopodoteuthopsis* sp.
Family Octopodidae	*Octopus* sp.1 *Octopus* sp.2 *Octopus* sp.3 *Octopus* sp.4 *Octopus* sp.5 *Octopus* sp.6 *Octopus* sp.7 *Octopus* sp.8 *Octopus* sp.9
Family Ommastrephidae	Rhynchoteuthion Larvae
Family Onychoteuthidae	*Onychoteuthis* sp.
Family Sepiolidae	*Euprymna* sp.

Family Cranchiidae

Family Characteristics: Mantle thin-walled, fused to head at nuchal region; fins vary in form and are separate, small, paddle-shaped, sub-terminal, medium-large, round, terminal to ovate or lanceolate, terminal or terminal-lateral; head short; eyes small - large with photophores.

Liocranchia sp.
Stout, spindle-shaped mantle: inverted V-shape, moderately long, tubercular cartilaginous strips at each funnel-mantle fusion point; protruding, but not stalked, oval eyes with photophores; small, separate, paddle-shape fins.

Liguriella sp.
Mantle stout, spindle-shaped; fins paddle-shaped in "larvae" <15 mm ML; head with medium to long arm-crown stalks; eyes oval, with short-ventral rostrum, on long stalks.

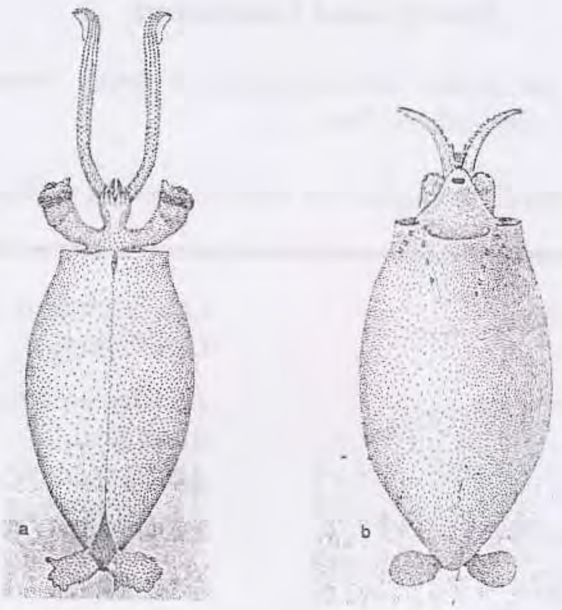

Figure 2. *Liguriella* sp. (a), *Liocranchia* sp. (b) (Voss,1980)

Family Enoploteuthidae

Family Characteristics: Photophores develop in a single row on each about 5 mm ML; numerous small photophores on the ventral surface of the mantle, funnel, head and arms begin to appear; photophores absent from tentacles and viscera. *Enoploteuthis* sp. and *Abralia* sp. are not easily identified but *Abraliopsis* sp. can be identified from others not only by their enlarged photophores on the tips of the ventral arms but also by their relative longer arms and tentacles. Characteristics in this family are likely to be useful for the separation of species including chromatophore patterns, size of largest club suckers relative to arm suckers, relative sizes among club suckers, number of club suckers, photophore patterns and photophore sizes.

Enoploteuthis sp.

Enlarged photophores absent at tips of arm IV, development of ocular photophores, begins with two photophores on each eye that develop into enlarged anterior and posterior ocular photophores.

Abralia sp.

Development of ocular photophores begins with 3 photophores on each eye.

Abraliopsis sp.

Tentacular club has 3 large hooks in a ventral row and small hooks or immature hooks in a dorsal row (5-12.1 mm DML), large photophores present on the tips of arm IV about 3-5mm ML.

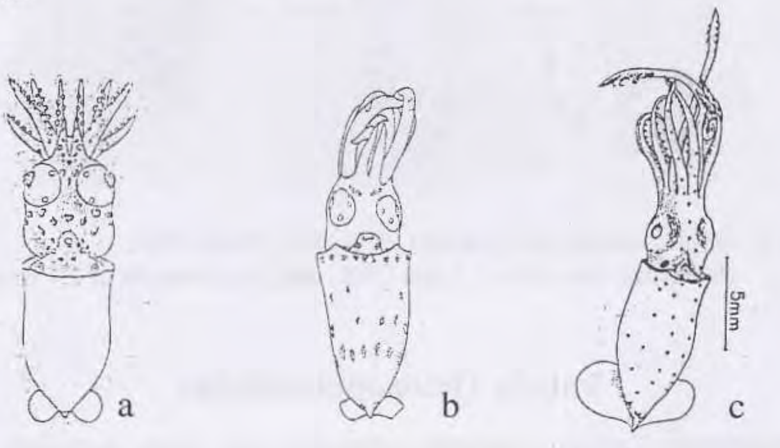

Figure 3. *Enoploteuthis* sp.(a), *Abralia* sp. (b) and *Abraliopsis* sp.(c)

Family Gonatidae

Family Characteristics: Characteristically head drawn into mantle up to the level of the eye lens in preserved conditions; arm IV is usually shorter than arms II and III

Gonatus sp.

Tentacular club with at least one large hook in the center; fins are terminal and connected together at their posterior ends.

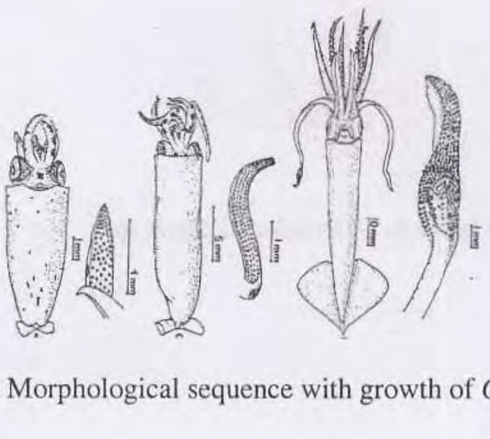

Figure 4. Morphological sequence with growth of *Gonatus* sp.

Family Lologinidae

Family Characteristics: Body forms of hatchlings are always bullet-shaped with well-developed terminal fins; well-developed ventral arms (arm IV>I) and tentacles.

Loligo sp.
The arms are short and the dorsal arm is not well differentiated.

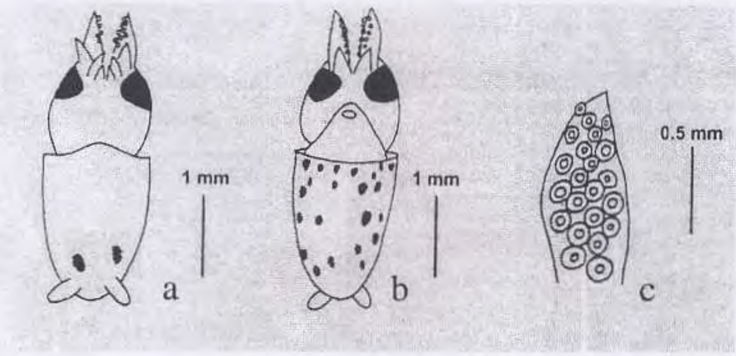

Figure 5. (a)-(c). *Loligo* sp. (a) dorsal view of a 1.7 mm DML (b) ventral view of a 1.7 mm DML and (c) a tentacle of 1.7 mm DML.

Family Octopodoteuthidae

Family Characteristics: Tentacles present; tentacular clubs short, spatulate, with 8 suckers in two rows; photophores present on some arm tips about 3-5 mm ML.

Octopodoteuthopsis sp.
The head is as wide as the mantle opening. The eyes are large. The tentacles are short.

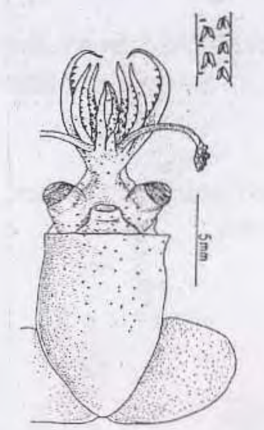

Figure 6. *Octopodoteuthopsis* sp.

Family Octopodidae

Family Characteristics: Body muscular to gelatinous; suckers uniserial or biserial; radula heterodont. The Octopodidae is the largest and most important family of octopods and one of the four most important families of cephalopods in regard to current and potential fishery exploitation.

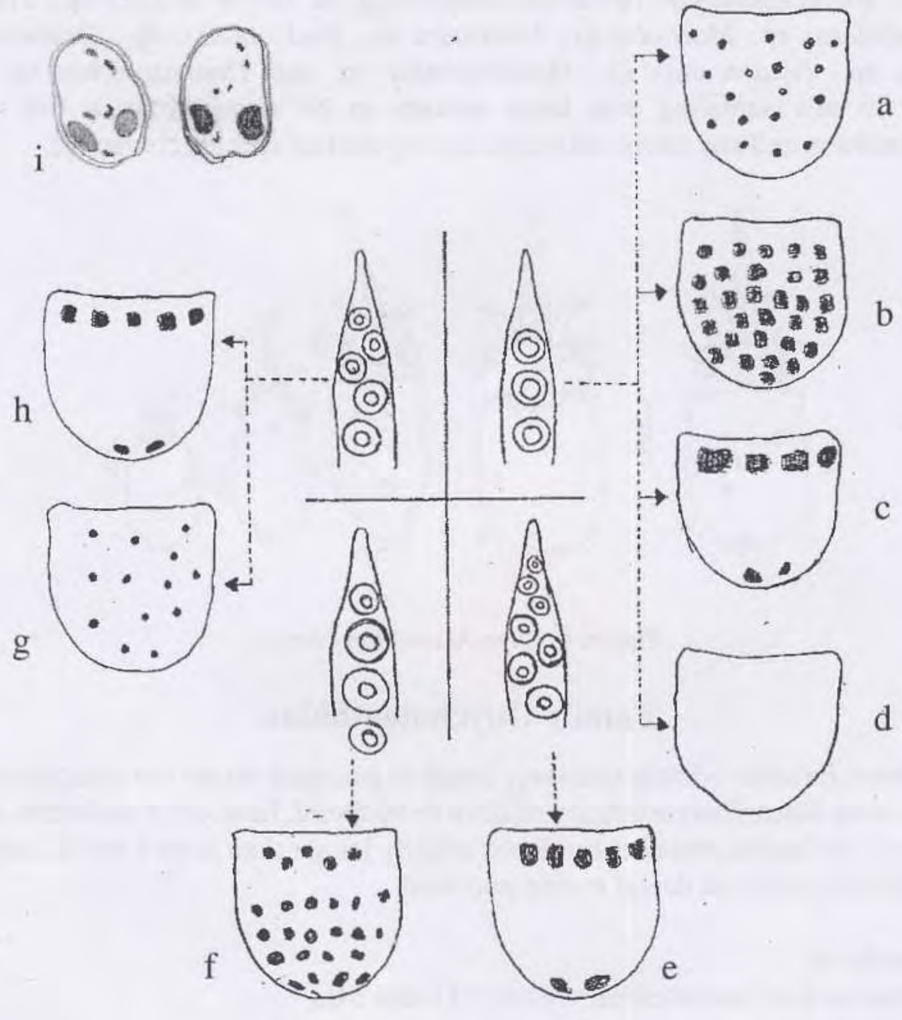

Figure 7. (a-i) *Octopus* sp., (a) *Octopus* sp.1, (b) *Octopus* sp.6, (c) *Octopus* sp.7, (d) *Octopus* sp.9, (e) *Octopus* sp.3, (f) *Octopus* sp.8, (g) *Octopus* sp.4, (h) *Octopus* sp.2 and (i) *Octopus* sp.5

Family Ommastrephidae

Family Characteristics: Distinctive "larval" form, the "Rhynchoteuthion" characterized by fusion of the tentacles into 9 "proboscis". Proboscis present at hatching (about 1 mm ML), division (separation) of proboscis proceeds as squid grows, proboscis stop growing in length once division begins, tentacles separate between 6 and 10 mm ML. Ommastrephidae larvae, the most of which are Rhynchoteution stage (Rhynchoteuthion larvae) 1-6 mm ML. In this stage both tentacles are fused into a single rod-like "rostrum". Rhynchoteuthion larvae are comprising the larvae of *Illex* sp., *Todaropsis* sp., *Notododarus* sp., *Martialia* sp., *Todarodes* sp., *Eucleoteuthis* sp., *Stenoteuthis* sp., *Dosidicus* sp., *Hyaloteuthis* sp., *Ornithoteuthis* sp. and *Ommastrephes* sp. but no specimen in this sampling was large enough to be regarded as a link between Rhynchoteuthion and any advanced stages having distinct species characters.

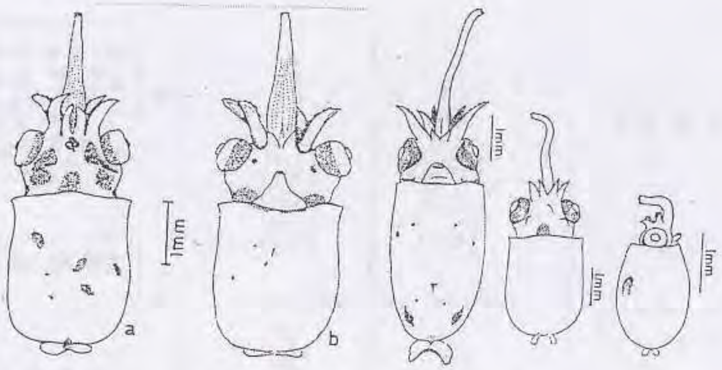

Figure 8. *Rhynchoteuthion Larvae*

Family Onychoteuthidae

Family Characteristics: Mantle relatively broad in youngest stages but sharply pointed posterior, often constricted anteriorly relative to midpoint, head often withdraw into the mantle up to eyelenses; tentacles thick and slightly longer than arms I and II; large, dark chromatophores occur on dorsal mantle and head

Onychoteuthis sp.
Photophores on eyes and intestine visible at 11 mm ML.

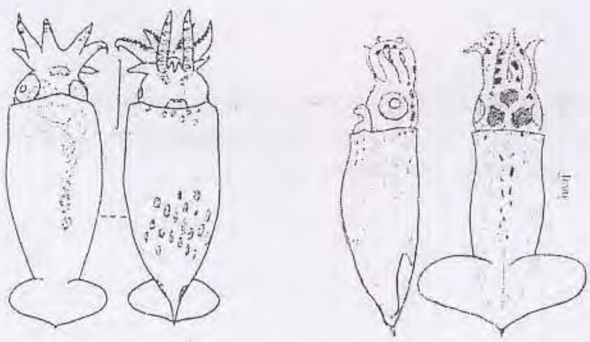

Figure 9. *Onychoteuthis* sp.

Family Sepiolidae

Family Characteristics: Shell reduced to chitinous gladius or absent in Euprymna and Stoloteuthis; mantle short, broad and sac-like; fins large, round, separated; mantle-funnel locking-cartilage simple, straight.

Euprymna sp.
Tentacular club with more than 16 sucker rows; fins large, round, separated the arm sucker arrangement is quadriserial even in the hatching (Allan, 1945) and easily separable from the present specimens.

Figure 10. *Euprymna* sp. 5 mm ML.

Abundance and distribution of cephalopod paralarvae in Sabah, Sarawak (Malaysia) and Brunei Darussalam waters were investigated and identified to 20 species of 9 families except for those unidentified (Table 1). The results of this investigation show that the most abundant cephalopod paralarvae were the family Enoploteuthidae (41.59%), followed by Ommastrephidae (25.64%) and Octopodidae (16.74%) (Table 2).

Family Enoploteuthidae was the most abundant in this study area comprising 41.59% of cephalopod paralarvae. In this study area the Enoploteuthidae consisted of *Enoplotuethis* sp., *Abralia* sp. and *Abraliopsis* sp. Most of the Enoploteuthidae larvae were *Abralia* sp. It was found that about 24.52%, were scattered throughout the northern part of the survey area (Figure A-1). *Enoplotuethis* sp. and *Abraliopsis* sp. were found to be 12.72% and 4.35%, respectively (Table 2). Both of these were distributed inshore rather than offshore especially in the waters off Sabah (Figure A-2 and Figure A-3).

The Rhynchoteuthion larvae were the second most abundant group of cephalopod paralarvae. The distribution pattern was offshore and at some inshore stations. The greatest abundance of Rhynchoteuthion larvae was found at station 10 (Figure A-4).

Gonatus sp., *Onychotuethis* sp., *Liocranchia* sp., *Euprymna* sp. and *Octopodoteuthosis* sp. were rare in this survey area. There were 0.33% at station 16, 0.46% at station 1, 1.38% at station 5 and 2.37% at station10, respectively (See Figure A-5 to Figure A-8).

Liguriella sp. also was seldom found in this study. There were only 3.36% at stations 9 and 15 (Figure A-9).

Loligo sp. was very common but few in number. They were found at only 2 stations, one inshore and another offshore (Figure A-10).

Octopus sp. was the third most abundant group of cephalopod paralarvae. The distribution was scattered throughout in waters of Sabah and Sarawak (Malaysia). They were found to be 16.74% in the waters both inshore and offshore (Figure A-11).

The distribution of cephalopod paralarvae in this survey area was scattered throughout the inshore and offshore waters of Sabah, Sarawak (Malaysia) and Brunei Darussalam especially in the northern part of the survey area (see in Figure 11).

Table 2. The cephalopod paralarvae abundance in Sabah, Sarawak (Malaysia) and Brunei Darussalam waters.

Family Cranchiidae	*Liocranchia* sp.	2.37%
	Liguriella sp.	3.36%
Family Enoploteuthidae	*Enoploteuthis* sp.	12.72%
	Abralia sp.	24.52%
	Abraliopsis sp.	4.35%
Family Gonatidae	*Gonatus* sp.	0.33%
Family Loliginidae	*Loligo* sp.	6.99%
Family Octopodoteuthidae	*Octopodoteuthopsis* sp.	1.12%
Family Octopodidae	*Octopus* sp.1	2.50%
	Octopus sp.2	5.21%
	Octopus sp.3	0.26%
	Octopus sp.4	0.26%
	Octopus sp.5	0.26%
	Octopus sp.6	4.75%
	Octopus sp.7	0.73%
	Octopus sp.8	0.33%
	Octopus sp.9	2.43%
Family Ommastrephidae	Rhynchoteuthion Larvae	25.64%
Family Onychoteuthidae	*Onychoteuthis* sp.	0.46%
Family Sepiolidae	*Euprymna* sp.	1.38%

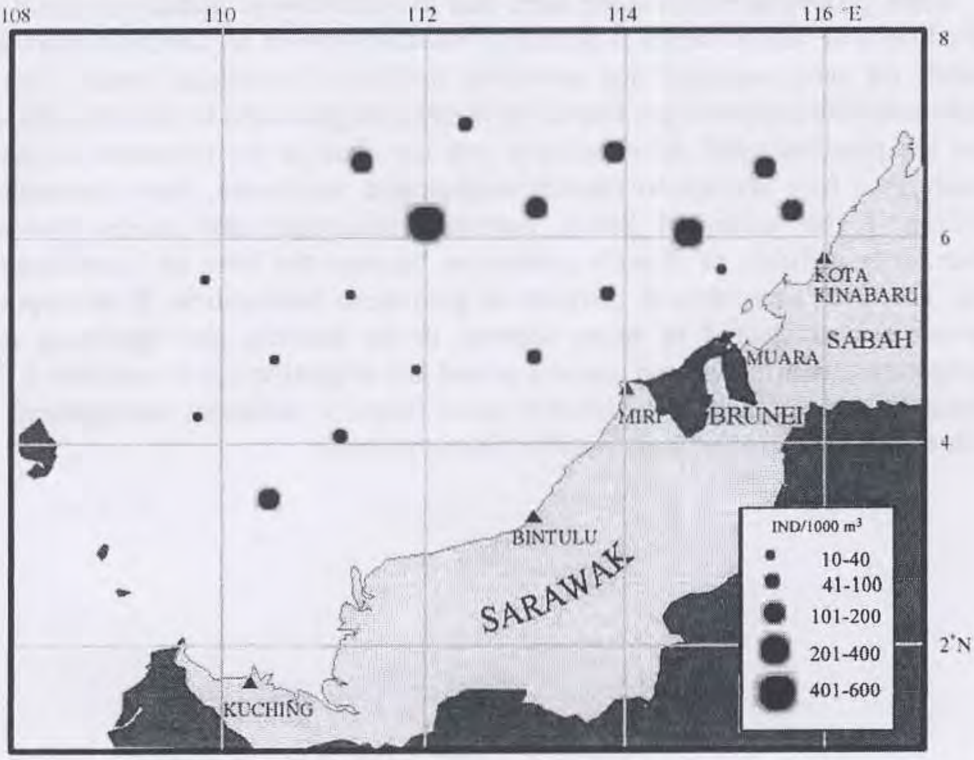

Figure 11. *The distribution of cephalopod paralavae in Sabah, Sarawak (Malaysia) and Brunei Darussalam waters between 20th March – 1st April 2000.*

The most abundant in this survey area were the family Enoploteuthidae, Ommasstrephidae and Octopodidae, but others like Gonatidae, Sepiolidae, Loliginidae, Cranchiidae, Octopodoteuthidae and Onychoteuthidae were seldom found in this study. As the rarest species in this study they may be distributed in any season, but we should continue to collect the specimens to support the data to learn about their spawning grounds and spawning seasons.

The Enoploteuthidae consisted of *Enoplotuethis* sp., *Abralia* sp., and *abraliopsis* sp., which were distributed in the northern part of the study area. The spawning grounds of *Enoplotuethis* sp. *Abralia* sp., and *abraliopsis* sp. could be inshore and offshore in the northern part of this survey area.

The Ommasstrephidae in this study were Rhynchoteuthion larvae. The Rhynchoteuthion larvae comprising the larvae of *Illex* sp., *Todaropsis* sp., *Todarodes* sp., *Eucleoteuthis* sp., *Rhynchoteuthis* sp.,*Ommastrephes* sp., and *Stenoteuthis* sp. The Rhynchoteuthion larvae could not be identified to generic or species because the larvae in this family have nearly the same characteristics in morphological terms. They can be identified in the older stages of juvenile and adult. The distribution area was offshore of Sabah and Brunei Darussalam.

The Octopus sp. was the third most abudant of cephlopod paralarvae in this study. The distribution area of this species was inshore and offshore of Sabah and Sarawak (Malaysia) waters.

Some problems in this study were that the cephalopod paralarvae could not be identified because identification is primarily based on growth sequences in photophores (especially on optic vescules) and armatures (hooks) of tentacular manus. Not much information on the morphology of larval to juvenile stages could be used for description because the phomorlogical differentiation was not clear in the immature stages. Also this study is a first attempt to identify cephalopod paralarvae, their abundance and distribution in the waters of Sabah, Sarawak (Malaysia) and Brunei Darussalam. However, it is difficult to identify paralarvae because the keys to identification are lacking. There isn't any data to compare to gain more information. If the cephalopod paralarvae were collected in more seasons or by months, the spawning ground, spawning period, rearing ground, rearing period and migration can be estimated. This is important for the planning of sustainable squid fisheries resources management in the near future and what are the most suitable fishing grounds.

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APPENDIX

Appendix I. Partial details of the cephalopod paralarvae sampling stations.

St. No.	Date	Local Time	Position		Depth (M)
			Latitude	Longitude	
1	20-Mar-00	05.55 - 06.26	03_26.5N	110_25.5E	65
2	20-Mar-00	11.20 - 11.50	04_07.8N	109_46.1E	100
3	20-Mar-00	18.30 - 19.00	05_34.0N	109_52.0E	145
4	21-Mar-00	06.25 - 06.56	04_46.6N	110_30.7E	118
5	21-Mar-00	15.37 - 16.07	04_01.5N	111_10.7E	71
6	22-Mar-00	06.25 - 06.55	04_41.7N	111_56.1E	88
7	22-Mar-00	06.33 - 17.02	05_27.1N	111_17.6E	420
8	23-Mar-00	16.11 - 16.41	06_13.0N	110_38.0E	1230
9	24-Mar-00	18.15 - 18.45	06_51.0N	111_22.5E	1904
10	25-Mar-00	06.40 - 07.10	06_01.6N	112_01.2E	1506
11	Only Oceanographic Survey				
12	26-Mar-00	06.28 - 06.58	05_04.7N	113_02.4E	131
13	26-Mar-00	16.37 - 17.06	05_37.5N	113_47.1E	2150
14	27-Mar-00	06.50 - 07.25	05_15.1N	114_20.2E	155
15	27-Mar-00	17.21 - 17.51	06_16.9N	114_32.8E	2090
16	28-Mar-00	06.25 - 06.55	06_43.7N	114_23.1E	169
17	28-Mar-00	15.46 - 16.16	06_56.5N	115_17.8E	1513
18	29-Mar-00	06.20 - 06.50	06_49.5N	115_42.2E	165
19	29-Mar-00	18.38 - 19.08	07_03.2N	113_52.1E	1842
20	31-Mar-00	05.52 - 06.23	07_06.7N	112_24.1E	1996
21	1-Apr-00	07.00 - 07.30	06_19.8N	113_06.1E	1597

Appendix II. Total volume of seawater, the number of cephalopod paralarvae and their abundance.

St. No.	Volume of water (m^3)	No. of cephalopod Paralarvae	Abundance (No./1000 m^3)
1	129.85	20	154
2	147.87	3	20
3	211.83	5	23
4	210.55	4	18
5	46.59	3	64
6	181.15	2	11
7	110.50	3	27
8	249.10	0	0
9	175.55	12	68
10	27.37	16	584
11		(Non-sampling)	
12	112.11	5	44
13	162.39	10	61
14	121.25	0	0
15	24.47	7	286
16	193.03	7	36
17	76.88	8	104
18	30.86	5	162
19	115.61	13	112
20	167.87	10	59
21	151.77	19	125

Appendix III. Occurrence of cephalopod paralarvae (ind/ 1000 m^3) by station.

Species / St. No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Euprymna sp.	0	0	0	0	22	0	0	0	0	0
Loligo sp.	85	0	0	0	0	0	0	0	23	0
Enoploteuthis sp.	0	0	0	0	0	0	0	0	0	0
Abralia sp.	23	0	0	0	0	0	0	0	0	0
Abraliopsis sp.	0	0	0	0	0	0	0	0	0	0
Rhynchoteuthion Larvae	0	0	4	0	0	0	0	0	29	256
Gonatus sp.	0	0	0	0	0	0	0	0	0	0
Onychoteuthis sp.	8	0	0	0	0	0	0	0	0	0
Liocranchia sp.	0	0	0	0	0	0	0	0	0	36
Liguriella sp.	0	0	0	0	0	0	0	0	11	0
Octopodoteuthopsis sp.	0	0	0	0	0	0	0	0	0	0
Octopus sp.1	38	0	0	0	0	0	0	0	0	0
Octopus sp.2	0	20	0	0	0	0	27	0	0	0
Octopus sp.3	0	0	0	4	0	0	0	0	0	0
Octopus sp.4	0	0	0	4	0	0	0	0	0	0
Octopus sp.5	0	0	0	4	0	0	0	0	0	0
Octopus sp.6	0	0	0	0	42	0	0	0	0	0
Octopus sp.7	0	0	0	0	0	11	0	0	0	0
Octopus sp.8	0	0	0	0	0	0	0	0	5	0
Octopus sp.9	0	0	0	0	0	0	0	0	0	0

Appendix III. (continued)

Species / St. No.	12	13	14	15	16	17	18	19	20	21
Euprymna sp.	0	0	0	0	0	0	0	0	0	0
Loligo sp.	0	0	0	0	0	0	0	0	0	0
Enoploteuthis sp.	0	0	0	0	5	91	98	0	0	0
Abralia sp.	8	61	0	204	11	0	0	9	18	33
Abraliopsis sp.	8	0	0	41	5	13	0	0	0	0
Rhynchoteuthion Larvae	8	0	0	0	5	0	0	43	6	33
Gonatus sp.	0	0	0	0	5	0	0	0	0	0
Onychoteuthis sp.	0	0	0	0	0	0	0	0	0	0
Liocranchia sp.	0	0	0	0	0	0	0	0	0	0
Liguriella sp.	0	0	0	41	0	0	0	0	0	0
Octopodoteuthopsis sp.	0	0	0	0	0	0	0	17	0	0
Octopus sp.1	0	0	0	0	0	0	0	0	0	0
Octopus sp.2	0	0	0	0	0	0	32	0	0	0
Octopus sp.3	0	0	0	0	0	0	0	0	0	0
Octopus sp.4	0	0	0	0	0	0	0	0	0	0
Octopus sp.5	0	0	0	0	0	0	0	0	0	0
Octopus sp.6	0	0	0	0	0	0	32	9	0	0
Octopus sp.7	0	0	0	0	0	0	0	0	0	0
Octopus sp.8	0	0	0	0	0	0	0	0	0	0
Octopus sp.9	0	0	0	0	5	0	32	0	0	0

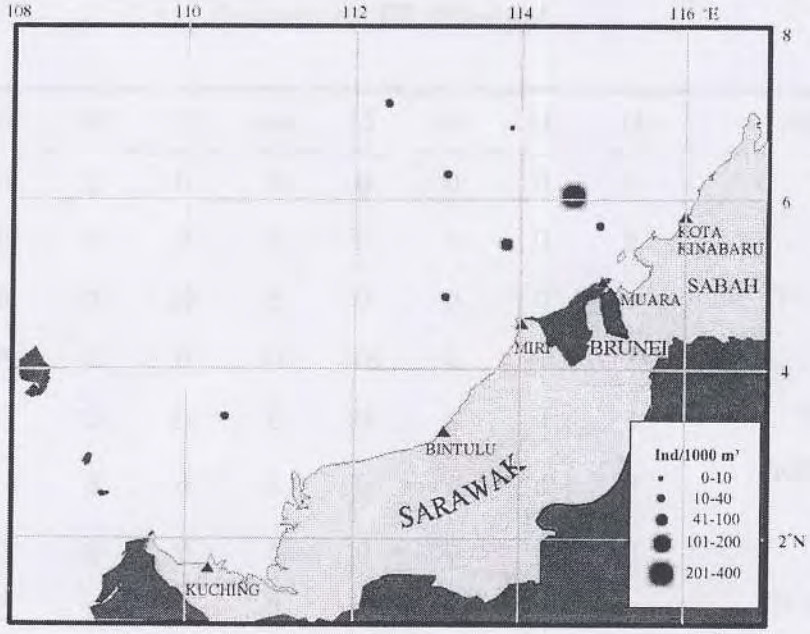

Figure A-1. *Distribution and abundance of Abralia* sp. *in Sabah, Sarawak (Malaysia) and Brunei Darussalam waters between 20th March – 1st April 2000.*

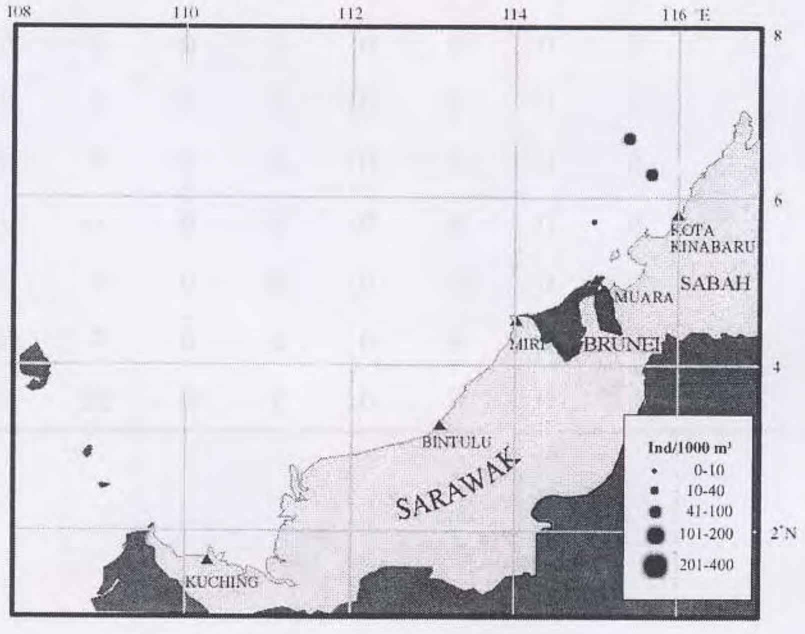

Figure A-2. *Distribution and abundance of Enoploteuthis* sp. *in Sabah, Sarawak (Malaysia) and Brunei Darussalam waters between 20th March – 1st April 2000.*

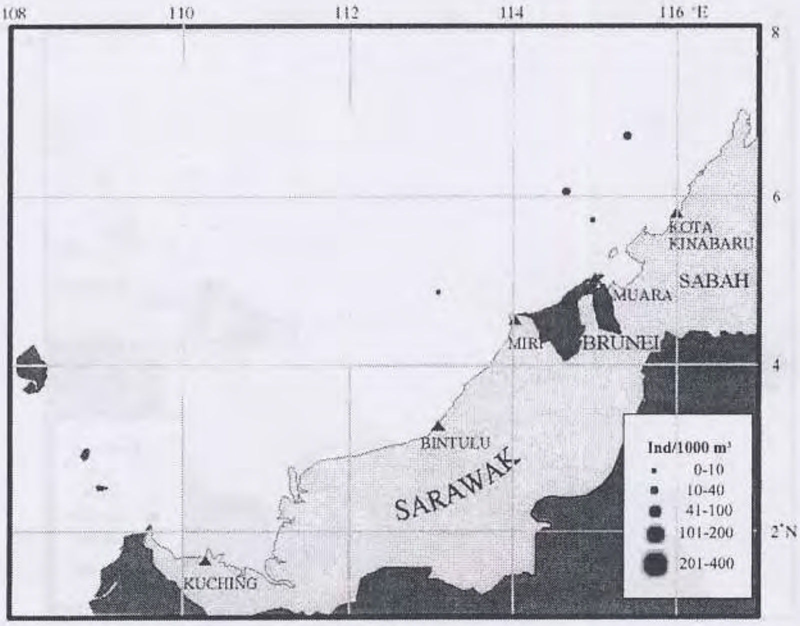

Figure A-3. *Distribution and abundance of Abraliopsis* sp. *in Sabah, Sarawak (Malaysia) and Brunei Darussalam waters between 20[th] March – 1[st] April 2000.*

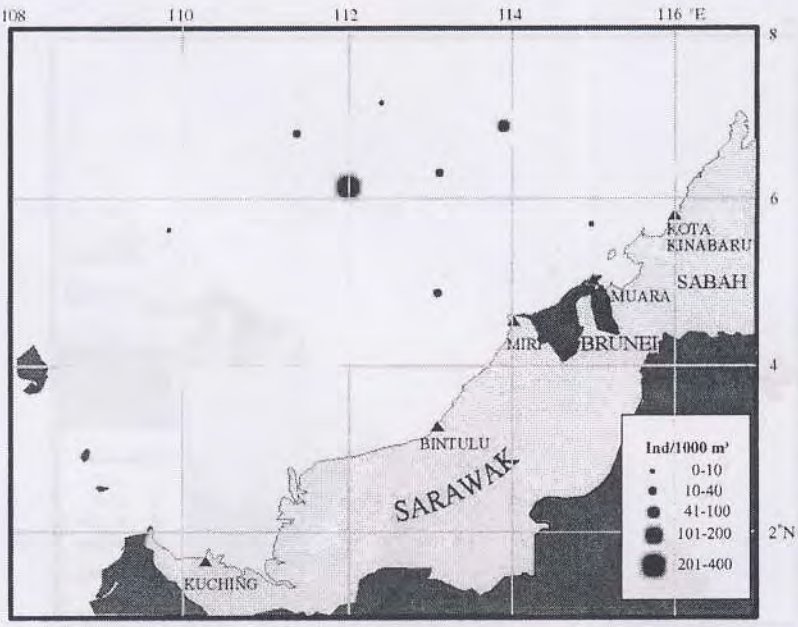

Figure A-4. *Distribution and abundance of Rhynchoteuthion Larvae in Sabah, Sarawak (Malaysia) and Brunei Darussalam waters between 20[th] March – 1[st] April 2000.*

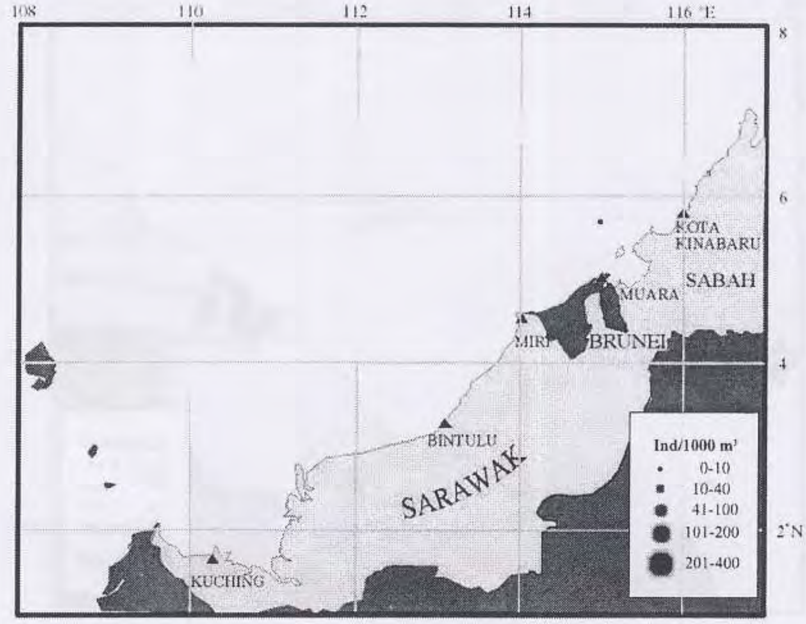

Figure A-5. *Distribution and abundance of Gonatus* sp. *in Sabah, Sarawak (Malaysia) and Brunei Darussalam waters between 20th March – 1st April 2000.*

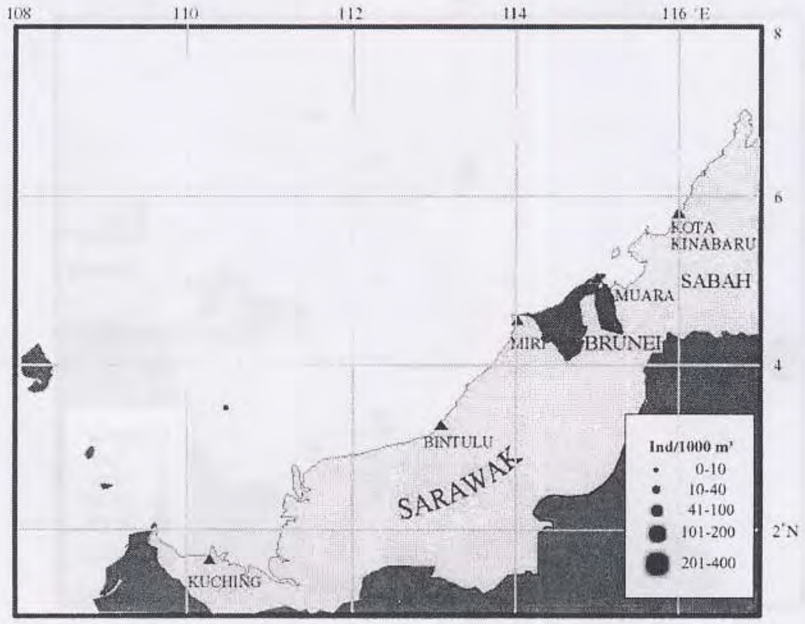

Figure A-6. *Distribution and abundance of Onychoteuthis* sp. *in Sabah, Sarawak (Malaysia) and Brunei Darussalam waters between 20th March – 1st April 2000.*

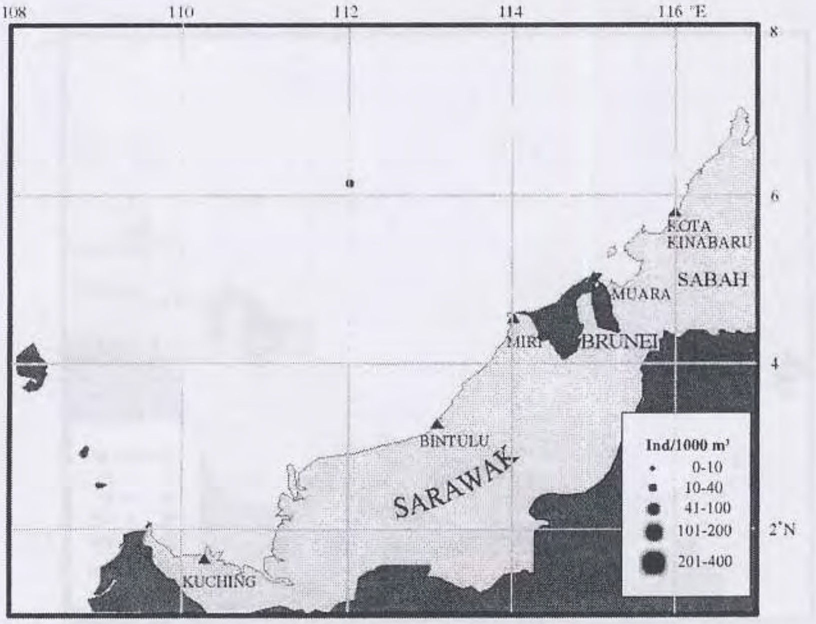

Figure A-7. *Distribution and abundance of Liocranchia* sp. *in Sabah, Sarawak (Malaysia) and Brunei Darussalam waters between 20th March – 1st April 2000.*

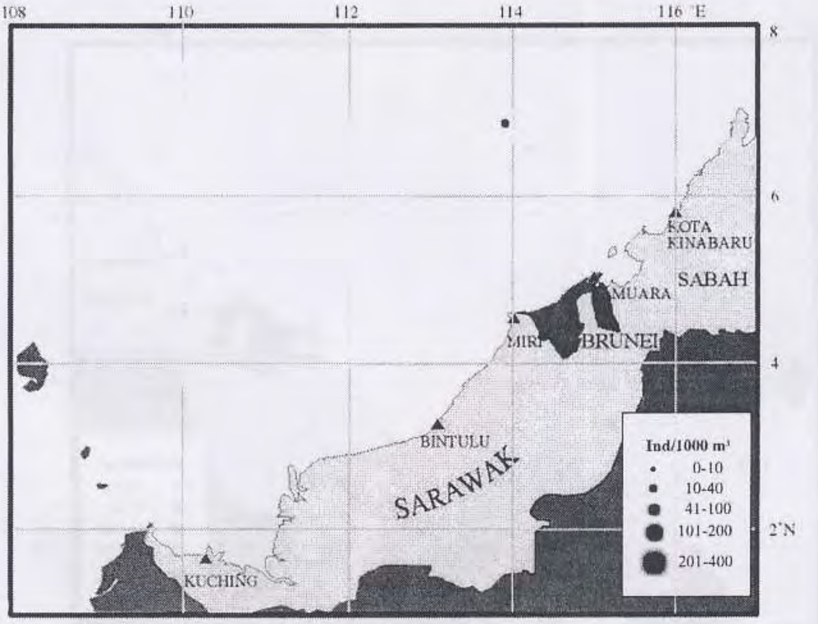

Figure A-8. *Distribution and abundance of Octopodoteuthosis* sp. *in Sabah, Sarawak (Malaysia) and Brunei Darussalam waters between 20th March – 1st April 2000.*

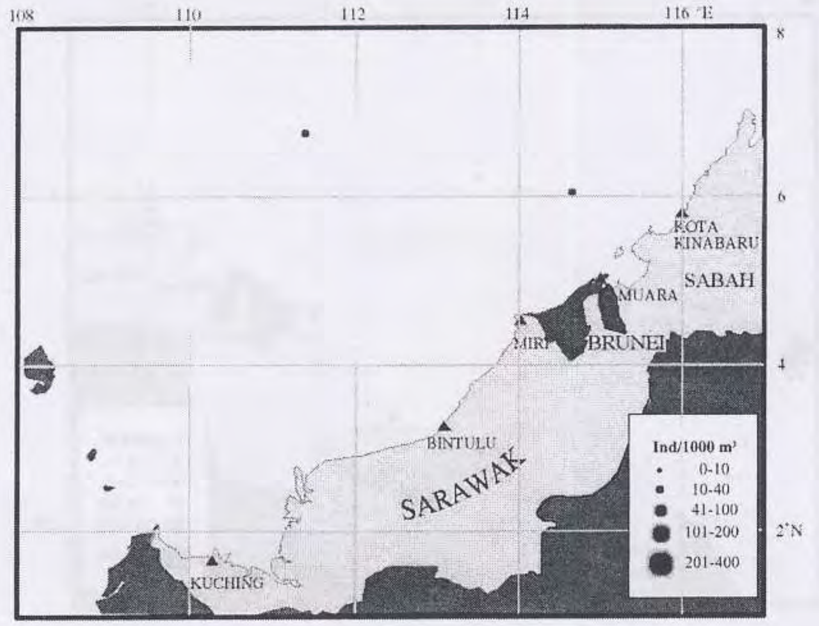

Figure A-9. *Distribution and abundance of Liguriella* sp. *in Sabah, Sarawak (Malaysia) and Brunei Darussalam waters between 20th March – 1st April 2000.*

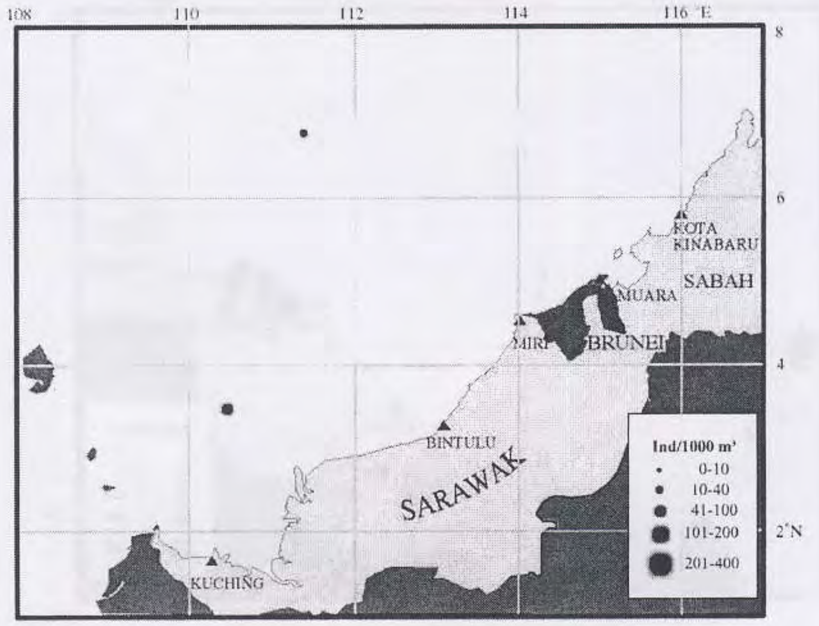

Figure A-10. *Distribution and abundance of Loligo* sp. *in Sabah, Sarawak (Malaysia) and Brunei Darussalam waters between 20th March – 1st April 2000.*

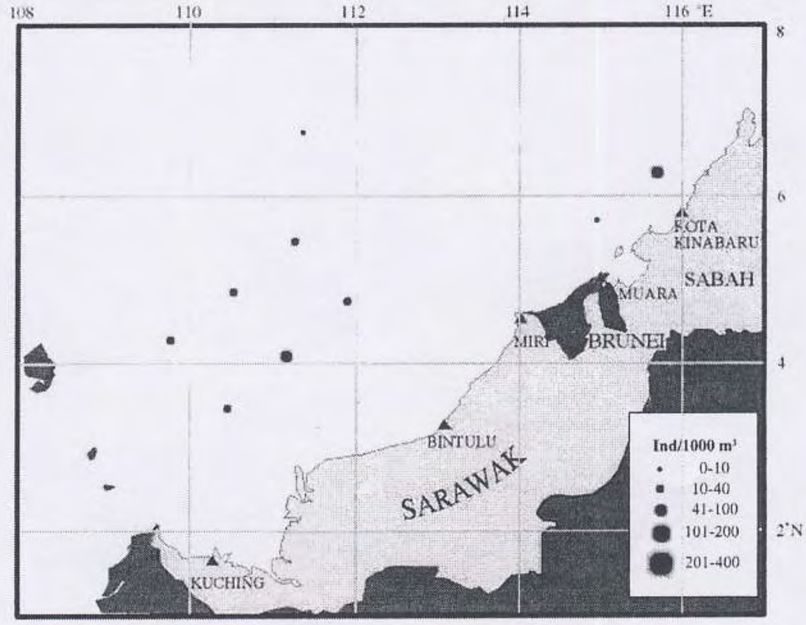

Figure A-11. *Distribution and abundance of Octopus* sp. *in Sabah, Sarawak (Malaysia) and Brunei Darussalam waters between 20th March – 1st April 2000.*